HORSE MANAGEMENT

FEEDING

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TABLE OF CONTENTS

INTRODUCTION 3

THE HORSE'S DIGESTIVE SYSTEM 4
- The Mouth 4
- Pharynx 4
- Esophagus 4
- Stomach 4
- Small Intestine 4
- Large Intestine 4
  - Cecum 4
  - Large Colon 5
  - Small Colon 5
  - Rectum 5

NUTRIENTS AND THEIR FUNCTION 6
- Water 6
- Protein 6
- Energy 6
- Minerals 9
  - Calcium and Phosphorus 9
  - Salt 9
  - Iodine 9
  - Magnesium 10
  - Selenium 10
  - Iron 10
  - Cobalt 10
- Vitamins 10
  - Vitamin A 10
  - Vitamin D 10
  - Vitamin E 10
  - Vitamin K 10
  - B-Complex Vitamins 10

FEEDS FOR HORSES 11
- Grains 13
- Roughages 13
  - Alfalfa Hay 13
  - Timothy 13
  - Straw 13
  - Silage 13
  - Pasture 13
- Protein Feeds 13
- Mineral Mixes 13
- Vitamin Mixes 14
- Other Feeds 14
  - Wheat Bran 14
  - Beet Pulp 14
  - Molasses 14
  - Pelleted Dehydrated Alfalfa Meal 14
  - Brewer's Dried Yeast 14
  - Stabilized Tallow 14
  - Conditioners 14
  - Complete Feeds 14

RATION FORMULATION 15

PRACTICAL FEEDING UNDER VARIOUS CONDITIONS 16
Winter Management 16
Pregnancy 16
Milk Production 17
Rebreeding Lactating Mares 17
Rearing Foals 17
Yearlings and Two-year Olds 18
Training 19

HORSE MANAGEMENT: FEEDING

Horse Industry Branch,
Alberta Agriculture

INTRODUCTION

Although horse people as a rule conscientiously try to feed well, a lack of basic understanding often results in an improper diet for the horse. Most novice horse owners and even many experienced producers do not appreciate and understand the importance of proper diets for horses.

Foals raised in Western Canada often do not reach their full potential in growth and performance because of improper feeding during their first year of life. This may be due to poor milking mares, mature or low quality pastures, lack of supplementation and the influence of cold winter conditions.

The number of foals born as a percent of mares exposed to stallions is unnecessarily low. Low quality pastures and lack of proper supplementation undoubtedly play a role as lack of proper nutrition reduces a mare's fertility.

Mature horses that are only ridden three or four hours per week tend to be too fat. The extra fat increases the risk of laminitis, decreases the horse's agility or usefulness and decreases the horse's natural tendency to exercise itself which aggravates the problems. Good pasture will allow an underworked horse to become fat.

On the other hand, heavy training greatly increases the horse's need for energy (grain) and proper allowances make the differences of winning or losing. Too often good quality hay and grain are substituted with improper supplements.

THE HORSE'S DIGESTIVE SYSTEM

Mouth

The mouth is made up of the cheeks on the side, the hard palate or roof above, the tongue on the floor, the teeth, the lips and the soft palate. (Fig. 1). The lips serve as scoops to pick up feed and pass it into the mouth aided by the action of the tongue.

The teeth are of two types, temporary and permanent. Functionally, they are organs of seizing and chewing as well as serving as weapons. The incisor teeth are located at the front of the horse's mouth. There are six above and six below. The canine teeth are situated a little further back and there are two in both the top and bottom. The premolar and molar teeth (six each, above and below) form the cheek teeth and are located in the sides and back of the dental arch. The premolars are in front of the molars. On the top side two extra premolars known as wolf teeth may be present.

The molar teeth initiate the mechanical process of particle size reduction, and the chewing action serves to mix the feed bolus with saliva to lubricate the mass for the act of swallowing. Some horses do not wear their molar teeth evenly causing points or sharp edges to form. These sharp edges damage the gums and interfere with the horse's ability to eat. A veterinarian can file the teeth down (float) to normal.

The horse uses its incisor teeth to clip off grass while grazing. Due to the closeness that horses can graze, they can be very damaging to pasture land if allowed to overgraze. Regrowth of pasture is not as efficient when grazed by horses as opposed to cattle. As well, the closeness at which horses are allowed to graze presumably increases chance of worm infestation.

Pharynx

This is a short funnel-shaped organ at the back of the mouth into which opens both the mouth and nasal passages. The pharynx aids in swallowing by forcing food into the esophagus. Once in the pharynx, food and air cannot return to the mouth, resulting in the horse's inability to breathe through its mouth.

Esophagus

The esophagus is a muscular tube, about 50 to 60 inches (130 - 150 cm) in length, which leads to the stomach. Rhythmic contraction of the esophagus moves food down (regurgitation of food is not possible).

Stomach

The stomach is an upright J-shaped sac located at the front and top of the abdominal cavity. The stomach is relatively small. Its capacity is two to four gallons (9 - 18 *l*), but can vary considerably in size, form and position. The horse is typically a slow and constant eater and thus does not require a large storage space. Although there is some sorting of food particles in the stomach, the material remains in the stomach for a short period of time (1 hour).

As in the pig, digestion in the stomach takes place by the action of digestive enzymes and acids. Digestive juices are secreted directly into the stomach where protein is broken down to free amino acids. Since the digestive juices do not break down fibre, hay is not digested in the stomach.

Small Intestine

From the stomach, food particles pass into the small intestine where further breakdown of food by enzymes occurs. The lining of the small intestine is in direct contact with the hepatic portal blood system so simple sugars, free amino acids (protein) and fats are absorbed into the blood stream from the small intestine. Most of the calcium and some of the phosphorus is absorbed from the small intestine. The small intestine is a narrow tube approximately 70 feet (21 m) in length with a capacity of about 12 gallons (54 *l*). The bulk of the small intestine is coiled near the left flank of the horse and it terminates at the cecum. Food moves through the small intestine by rhythmic smooth muscle contractions. Fibrous food (hay) apparently moves through the small intestine faster than fine feed (grain).

Large Intestine

The large intestine consists of the cecum, the large and small colon, the rectum and the anus.

Cecum

The small intestine runs into the cecum which is a large pouch that is located where the appendix is in the human or pig. It extends from high in the right flank downward and forward towards the region of the diaphragm. The opening to the colon is within two to three inches (5 - 8 cm) of the outlet from the small intestine so this organ is sometimes called the blind sac. The cecum is about 4 feet (1.2 m) long and holds 7 or 8 gallons (31 - 36 *l*). Digestion in the cecum is similar to that of the rumen in cattle. The cecum is like a large fermentation vat where millions upon millions of microorganisms (bacteria, protozoa) live on ingested food. The bacteria break down the fibrous or cellulose portion of feed and yield end-products that are utilized by the horse. Carbohydrates are

broken down to volatile fatty acids which are absorbed directly from the cecum and used as a source of energy by the horse. As in the rumen, B-vitamins are synthesized by the microorganisms and are available to the horse. The cell walls of bacteria are composed of protein which can be synthesized from free nitrogen. The bacteria that are carried into the colon are available as a source of protein for the horse, however, the extent of amino acid absorption from the colon is not known and is presumed to be of minor importance.

Exercise is extremely important in digestion in the horse as the horse depends to a large extent upon exercise for the movement of ingesta through its digestive system as the smooth muscle contractions in the cecum are not as efficient as in the rumen of cattle. Colic is the usual symptom of problems occurring because of improper movement or digestion of food.

The cecum has the ability to expand or decrease in capacity depending upon the type of diet. Race horses, for example, are fed very little roughage and the cecum decreases in size and function. As a result, race horses should be fed supplemental B-vitamins. Horses wintered on low quality feed often develop a very large cecal capacity because the material requires a long time (up to 72 hours) to be digested. The large abdomen is unsightly and affects the horse's athletic ability but can be brought back to normal by proper feeding and exercise.

Because of the location of the cecum, the horse is more efficient than cattle in digesting grain and high quality protein sources as most of this digestion takes place in the stomach and small intestine and is not affected by the microorganisms. Microorganisms are somewhat inefficient in digesting high quality feed because they have to maintain their own bodies. Considerably more heat is produced by bacterial fermentation as opposed to digestion in the stomach and small intestine.

On the other hand, horses do not utilize roughages as well as cattle do since very little use is made of the protein formed in the cecum and of the material after it leaves the cecum.

If the horse's diet only contains high quality protein, little remains for proper bacterial fermentation in the cecum.

Large Colon

The large colon measures about 10 to 12 feet (3 - 3.7 m) in length with a diameter of 8 to 10 inches (20 - 25 cm) and a net capacity of 20 gallons (90 *l*). Although little absorption of nutrients occurs in the colon of monogastric animals, the ability of the horse to absorb nutrients from the colon is not known.

Small Colon

The small colon, which measures 10 to 12 feet (3 - 3.7 m) in length with a 3 to 4 inch (7 - 10 cm) diameter, begins to collect the undigested feed and begins to form the ball-shape feces of the horse. Any residual moisture is extracted in this location and reabsorbed for further use.

Rectum

The rectum is a 12 inch (30 cm) extension of the small colon which passes through the pelvic girdle and ends in the anus, which is the termination of the digestive tract.

DIGESTIVE TRACT OF THE HORSE

FIGURE 1: MOUTH, PHARYNX AND ESOPHAGUS

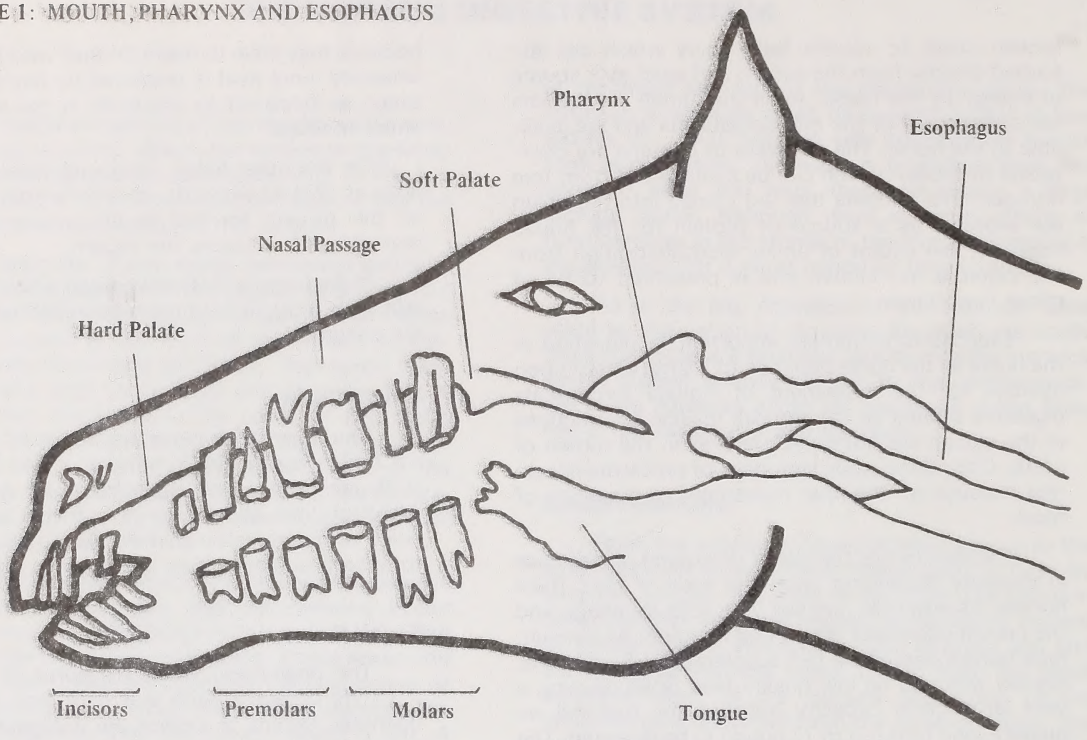
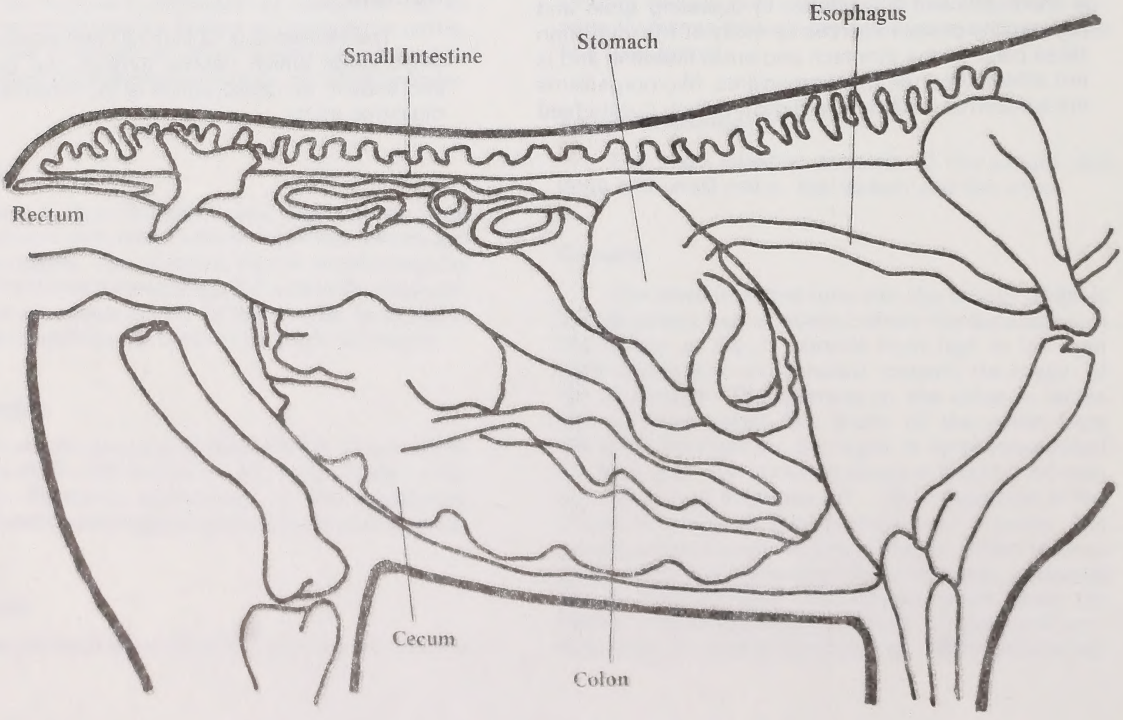


FIGURE 2: STOMACH, COLON, CECUM AND RECTUM



NUTRIENTS AND THEIR FUNCTION

Horse feeders should avoid thinking in terms of feeding their horse so many pounds of hay and oats and start thinking in terms of meeting the horse's nutrient requirements. Nutrients are the components of feed required by the horse. The nutrients in feeds are water, protein, energy, vitamins and minerals.

A proper diet for a horse is one that contains a combination of feeds that closely meets the horse's nutrient requirements. If a feed ingredient is not a nutrient, the product has little value.

Water

From the horse's point of view, water is the most important nutrient. Water, in the form of body fluids, makes up approximately 60 per cent of the live-weight of a mature horse. Water aids in the transport of other nutrients, removal of body wastes, control of body temperature, lubrication and many other body functions.

Horses require about 3 pounds of water for each pound of feed consumed (3 kg of water for each kilogram of feed consumed). Intakes may be higher for high protein feeds, during warm weather, fast growing foals, lactating mares or heavily worked horses. Intakes may be lower during cold weather, when horses are only watered once per day, or when horses are forced to eat snow to meet their water requirement. Insufficient water intake can reduce growth rates, vigor and digestion of feeds by horses.

Horses should have continual access to good, fresh, clean water that has had the chill removed. Heated water bowls are the most satisfactory way of supplying water to horses, especially growing foals.

Protein

Horse feeds contain five to 20 per cent protein. Chemically, a protein is composed of strings of amino acids.

Lysine, tryptophane and methionine are examples of amino acids that are commonly deficient in animal rations. Soybean meal is a good source of amino acids. Animals require amino acids (protein) to form muscle tissue and soft organs. When protein is consumed, digestive enzymes reduce it into free amino acids which are absorbed through the walls of the small intestine into the blood stream. The blood carries the free amino acids to the growth site where they are deposited in an order specific for the type of protein (muscle, glands, etc.). Different arrangements of amino acids form protein with varying physical characteristics. Thus, pig muscle is not the same as beef muscle and protein from plants vary.

In the horse, ingested protein is first acted upon by acids and enzymes in the stomach and small intestine. Free amino acids are absorbed directly from the small intestine relatively unchanged. The body has the ability for changing excesses of some amino acids into ones that are required for growth, but several acids cannot be synthesized. These are the essential amino acids. Protein quality is determined by content of essential amino acids. Grain contains eight to 20 per cent protein that is relatively low in quality because it is low in lysine and methionine. A high quality protein such as soybean meal is often added to horse rations to raise the level of the limiting essential amino acids.

The horse's requirement for protein depends upon rate of growth, stage of pregnancy, and milk production. For example, new born foals require approximately 22 per cent protein; weanlings, 14 per cent protein; yearlings, 12 per cent protein and mature horse eight to 10 per cent protein in their diets. Pregnant and lactating mares require approximately 12 per cent protein in their diet. As can be seen in Table 1, horses require a set number of pounds of protein per day. Thus, the percentage in their ration varies considerably depending on the number of pounds of ration fed each day. Since not all the protein is usable or digestible, the table also lists the amount of digestible protein required by the horse. In general, protein in grain is about 80 per cent digestible and hay 50 per cent.

Protein deficiency is very common in horses under one year of age. A deficiency of protein in young horses will reduce the growth of muscle and bone even though the horse may appear fat. A prolonged protein deficiency will actually stunt the foal. Protein deficiency in older animals leads to muscle deterioration, especially noticeable in the hip and hind legs. The horse may also have a poor hair coat, lose weight and have a poor appetite.

Energy

Energy is the main component of horse feeds as it includes the starches, sugars, celluloses (fibre) and fat in plants.

Since most of what is fed to a horse is meant to supply energy, energy becomes the most important ingredient from an economic aspect. In ration formulation, a mixture of feeds are chosen to supply adequate amounts of energy and then a check is made to determine if the horse is receiving sufficient protein, minerals and vitamins.

Energy is used to string amino acids together in the formation of muscle tissue, to keep the vital organs functioning, to contract muscles during

TABLE 1 — NUTRIENT REQUIREMENTS OF HORSES

Body Weight (lb.)	Daily (air dry) Feed[a] (lb.)	Digestible Energy (Mcal)	TDN (lb.)	Protein (lb.)	Digestible Protein (lb.)	Vitamin A (thousands I.U.)[b]	Calcium (g)	Phosphorus (g)
			MAINTENANCE					
Mature Horses at Rest (maintenance)								
440	7.3	8.24	4.12	.66	.35	5.0	8.0	6.0
881	12.3	13.86	6.93	1.11	.59	10.0	16.0	12.0
1101	14.6	16.39	8.20	1.31	.70	12.5	20.0	15.0
1321	16.7	18.79	9.40	1.51	.80	15.0	24.0	18.0
			WORK					
Mature Horses at Light Work (2 hr/day)								
440	9.3	10.44	5.22	.84	.44	5.0	8.0	6.0
881	16.4	18.36	9.18	1.48	.78	10.0	16.0	12.0
1101	19.5	21.89	10.95	1.77	.93	12.5	20.0	15.0
1321	22.6	25.39	12.70	2.05	1.08	15.0	24.0	18.0
Mature Horses at Medium Work (2 hr/day)								
440	11.7	13.16	6.58	1.06	.56	5.0	9.2	7.0
881	21.2	23.80	11.90	1.92	1.01	10.0	17.2	13.0
1101	25.5	28.69	14.35	2.31	1.22	12.5	21.2	16.0
1321	29.9	33.55	16.78	2.71	1.43	15.0	25.2	19.0
			GROWTH					
440 lb. Mature Weight								
110	7.19	7.43	3.72	1.16	.84	2.0	17.4	10.9
198	7.59	8.53	4.27	1.02	.69	3.6	16.6	10.4
297	7.07	7.95	3.98	.74	.45	5.4	12.0	7.5
363	7.19	8.08	4.04	.69	.40	6.6	10.4	6.5
440	7.34	8.24	4.12	.66	.35	5.0	8.0	6.0
880 lb. Mature Weight								
187	9.30	10.44	5.22	1.63	1.22	3.4	26.1	16.4
374	11.04	12.41	6.21	1.41	.95	6.8	35.0	21.9
573	12.14	13.63	6.82	1.32	.81	10.4	22.0	14.8
727	12.55	14.10	7.05	1.27	.75	14.2	19.0	13.8
881	12.33	13.86	6.93	1.11	.59	10.0	16.0	12.0
1100 lb. Mature Weight								
242	10.74	12.07	6.04	1.84	1.36	4.4	30.5	19.1
496	13.70	15.40	7.70	1.76	1.18	9.0	46.0	28.7
716	14.95	16.81	8.41	1.65	1.04	11.0	26.0	17.4
881	15.27	17.16	8.58	1.54	.92	16.0	23.0	16.1
1101	14.58	16.39	8.20	1.31	.70	12.5	20.0	15.0
1320 lb. Mature Weight								
309	12.60	14.15	7.08	2.11	1.55	5.6	52.0	32.2
584	15.32	17.21	8.61	1.92	1.28	10.6	51.2	32.0
848	16.79	18.86	9.43	1.84	1.15	15.4	32.9	20.6
1057	17.08	19.20	9.60	1.71	1.01	19.2	31.3	19.6
1321	16.71	18.79	9.40	1.51	.80	15.0	24.0	18.0
			PREGNANCY AND LACTATION					
Mares, Last 90 Days of Pregnancy								
440	7.7	8.70	4.35	.80	.48	10.0	10.4	8.0
881	13.2	14.88	7.44	1.35	.83	20.0	19.5	15.0
1101	15.4	17.35	8.68	1.60	.96	25.0	24.0	18.0
1321	17.7	19.95	9.98	1.84	1.11	30.0	28.0	21.0
Mares, Peak of Lactation								
440	13.6	15.24	7.62	1.65	1.06	10.0	34.0	23.4
881	21.8	24.39	12.20	2.60	1.65	20.0	42.0	35.6
1101	24.6	27.62	13.81	2.90	1.83	25.0	47.0	38.6
1321	26.7	30.02	15.01	3.09	1.93	30.0	64.0	43.4

[a] Minimum intakes

[b] One mg of beta-carotene equals 400 I.U. of vitamin A.

movement and work, and to keep the animal warm during the winter time.

Excess energy is stored in the animal's body as fat. The main sites for fat storage are over the back and around the kidneys. Stored fat can be used to meet the horse's energy needs when inadequate amounts are supplied in the daily diet.

The energy value of a feed is expressed as its per cent of total digestible nutrients (TDN). TDN is the sum of the components that are digested to provide energy. Grains are a concentrated source of energy or TDN (oats — 65 - 70 per cent; barley 75 per cent; wheat — 82 per cent). Hays are much bulkier or more fibrous and as a result have a lower energy value (40 - 55 per cent TDN).

A deficiency of energy results in reduced growth, loss of weight, poor digestion, poor reproductive performance, lack of vigor and weakness; all of which is known as starvation. Unfortunately, starvation is very common among horses in Western Canada during winter and especially among horses less than one year of age.

Excess energy causes the horse to become overfat which makes the horse more prone to laminitis and decreases the horse's agility or activity thus aggravating the overweight problem. Inactive mature horses will become overweight on good quality pasture. Overweight horses are very common among those owned by people who only ride three to five hours a week. Pregnant mares that are too fat may have difficulty developing and delivering a healthy foal.

Minerals

Essential minerals include calcium, phosphorus, sodium, chlorine, iron, iodine, cobalt, selenium, fluorine, potassium, magnesium, sulphur, manganese, copper, zinc and molybdenum. Most of the minerals are present in adequate amounts in feeds but deficiencies of calcium, phosphorus, salt (sodium and chlorine) and iodine are common and supplementation is usually required. Special area problems may occur where soil and plants are too high (toxic) or too low in one or more of the other minerals.

Calcium and Phosphorus

Calcium and phosphorus are the main components of bones, and thus for proper development and maintenance of bone in horses, these two elements are required in adequate quantities and in proper proportions. The ratio of calcium to phosphorus should be maintained between 1.2:1 and 2:1. Recommended allowances are shown in Table 2.

TABLE 2. CALCIUM AND PHOSPHORUS REQUIREMENTS OF HORSES.

	mg/kg/day		% of diet	
	Ca	P	Ca	P
Young Horses				
Weanlings	150-180	90-110	0.7	0.4
Yearlings	110-130	65-75	0.6	0.35
Adult Horses				
Maintenance	35-60	20-40	0.35	0.25
Pregnancy	60-85	35-55	0.4	0.3
Lactation	115-140	55-75	0.6	0.35
Light exercise	60-75	35-45	0.4	0.3

If there is more available phosphorus than calcium, an imbalance occurs whereby calcium becomes unavailable to the horse. Deficiencies of calcium and phosphorus lead to reduced bone growth, stunting, abnormal development of foals (crooked legs) and bones that are more easily fractured or injured. Excesses of calcium and phosphorus can also result in abnormal bone development and imbalances with other elements.

In general, grains tend to be very low in calcium and borderline in meeting phosphorus needs whereas roughages tend to be very low in phosphorus and borderline in calcium. Hay-grain rations tend to supply adequate amounts of calcium and phosphorus for mature horses but are always low for growing foals and often low for pregnant and lactating mares.

Salt (Sodium Chloride)

Salt in the diet makes feed more palatable and is essential to many body functions such as the formation of digestive juices and the maintenance of osmotic balance in the body. Salt deficiencies may result in reduced appetite, rough hair coat and generally reduced performance.

Supplemental salt is required in all horse diets as natural feed stuffs are deficient. Horses should be allowed 50 to 60 g of salt daily and more where excessive perspiration occurs. Until this salt is replaced, the horse may show signs of fatigue or overheating. Salt can be included in a concentrate ration at a level of 0.5 to 1.0 per cent. In addition, salt should always be available free choice in a mineral box wherever horses are kept.

Iodine

Iodine is an essential component of thyroxine, the hormone manufactured in the thyroid gland which plays a key role in the regulation of metabolism. Iodine is lacking in soils in certain areas of Western Canada. Iodine deficiency results in birth of either

still-born, weak or sometimes hairless foals. Their pulse rate may be high and their breathing labored. The possibility of deficiency can be eliminated by feeding iodized salt to all classes of horses at all times. The actual requirement is estimated to be 0.1 ppm* in the diet. Excesses of iodine (40 mg/day) are toxic and can lead to goiter. Kelp and iodized salt are sources of excess iodine.

Magnesium

Magnesium serves as an activator for a number of metabolic enzymes, and occurs in significant quantities in bone. The requirement is estimated to be 14 mg/kg of body weight daily.

Deficiencies of this element have been reported in horses fed very lush forage. The symptoms, sometimes collectively termed 'grass tetany', are hyper-irritability, convulsions and ultimately collapse in death. Magnesium deficiency is not considered to be a problem in Western Canada.

Selenium

This mineral is required by horses. Deficiency produces a muscular dystrophy known as white muscle disease which occurs in areas where the soil has low selenium content. It has been reported in ruminant animals consuming forages grown on Gray Wooded soil. These forages tend to be considerably lower in selenium than those grown on Dark Brown or Brown soil. In deficient areas selenium supplementation is given to pregnant mares and to foals at birth.

Iron

Iron is an essential component of the oxygen-transport protein, hemoglobin. A deficiency results in anemia. The requirement is estimated to be 40 ppm for maintenance and 50 ppm for growth. Natural feedstuffs contain adequate amounts of iron and deficiencies are unlikely.

Cobalt

The only known function of cobalt is as a constituent of Vitamin B_{12}. The precise requirements are unknown, but are apparently considerably lower than for ruminant animals. Deficiencies have not been reported.

Vitamins

The vitamins are usually divided into two classes: fat-soluble and water-soluble. The fat-soluble include vitamins A, D, E and K. The water-soluble vitamins include the B-complex (or group) and vitamin C. Horses do not require a dietary source of vitamin C.

Vitamin A

Vitamin A occurs in forages (pasture or good quality hay) as a precursor (β-carotene) which is converted to the true vitamin in the intestinal mucosa. β-carotene is unreliable as a source of vitamin A, except for animals grazing good quality pasture because it is readily destroyed by oxidation in stored forages. The requirement should be met by adding stabilized synthetic vitamin A to the ration.

Deficiencies of vitamin A can occur as readily in horses as in other species of domestic animals. Symptoms include night blindness, excessive tearing, loss of appetite, rough hair coat, respiratory difficulties and bone lesions, as well as severely impaired resistance to disease.

Vitamin D

The primary function of this vitamin is in the absorption of calcium from the small intestine. It is involved also in the mineralization of bone. Deficiencies are uncommon, but do occur and result in rickets in young horses and reduced bone calcification, swollen joints and stiffness of gait in adults. Vitamin D is present in good quality, sun-cured forages. Precursors of the vitamin, which can be activated by sunlight, occur naturally in the sebaceous secretions of the skin. Generally speaking, vitamin D deficiency will occur only in animals kept indoors most of the time and a vitamin D supplement should be included. Precise requirements have not been established, but a level of 6.6 I.U./kg of body weight daily is believed adequate.

Vitamin E

The functions of vitamin E are interrelated with those of selenium, and conditions such as white muscle disease are generally treated with a combination of selenium and vitamin E. Requirements are unknown. There is considerable doubt about the ability of vitamin E to improve reproductive efficiency in horses, and no sound basis for recommending its routine addition to horse rations.

Vitamin K

This vitamin, which is involved in several stages of the blood clotting process, is synthesized in more than adequate amounts by the intestinal microflora. There is no need for dietary supplements.

B-complex Vitamins

There is insufficient information as to requirements of these vitamins and the need for supplementation of horse rations. Monogastrics, generally speaking, require supplemental B-vitamins, whereas ruminants do not, since considerable microfloral syn-

*ppm - parts per million

thesis occurs in the rumen. With horses, B-vitamin synthesis occurs in the cecum and supplemental B vitamins are not necessary. A possible exception is stressed horses fed low roughage diets.

The following levels are believed to represent adequate intakes:

Thiamine — 3 mg/kg of feed
Riboflavin — 2.2 mg/kg of feed
Niacin — 0.01 mg/kg of body weight
Pantothenic acid — 2 mg/kg of feed
Vitamin B_{12} — 6 mg/head daily

FEEDS FOR HORSES

From a nutritional aspect, feeds contain various proportions of water, energy, protein, vitamins and minerals. However, from a practical aspect, feeders must consider toxic factors, odors, tastes, laxative properties and physical characteristics such as bulkiness, hardness and sharpness of specific feeds when preparing rations for horses.

Energy in feeds, derived from the fat and carbohydrates (sugars, starches, fibre), is the main component of grains and roughages. Total digestible nutrients (TDN) is a measure of the amount of useful

TABLE 3 — COMPOSITION OF ROUGHAGES
(values based on 90% dry matter content)

Feedstuff	TDN		Crude Protein			Calcium		Phosphorus		Vitamin A activity[a]	
	Range (%)	Average (%)	Range (%)	Average (%)	Digestible protein	Range (%)	Average (%)	Range (%)	Average (%)	Range ('000 I.U./kg)	Average ('000 I.U./kg)
Legume hay:											
Alfalfa[c]	40-70	55	8-25	16.3	11.4	0.32-1.84	1.08	0.02-0.30	0.16	0-117	50.2
Clover hay[c]	46-52	49	10-18	14.0	9.8	0.75-1.07	0.91	0.08-0.32	0.20	—	23.8
Grass hay:											
All analysis[c]	39-57	48	2-15	8.7	4.4	0.08-0.60	0.34	0.05-0.25	0.15	0-66	16.7
Bromegrass	42-55	48	3-28	12	6.0	—	0.40	—	0.20	0-88	—
Prairie	40-50	45	2-9	6	3.0	—	0.35	—	0.10	0-33	—
Marsh	40-48	44	8-12	10	5.0	—	0.30	—	0.10	0-33	—
Timothy	42-54	48	4-17	8	4.0	—	0.37	—	0.19	0-33	—
Mixed hay:											
Alfalfa-grass[c]	44-58	51	6-18	11.9	6.5	0.04-1.68	0.86	0.08-0.24	0.16	0-29	12.3
Clover-grass[c]	37-57	47	4-18	11.3	6.2	0.42-0.78	0.60	0.10-0.34	0.22	—	—
Cereal hay:											
All analysis[c]	38-58	48	4-15	9.4	5.2	0.02-0.50	0.26	0.06-0.30	0.18	0-25	7.4
Oat	45-50	48	4-14	7	4.2	—	0.26	—	0.24	0-88	—
Barley	45-50	48	7-15	8	4.4	—	0.21	—	0.30	0-55	—
Wheat	45-50	48	5-9	7	3.9	—	0.12	—	0.16	0-55	—
Straw:											
All analysis[c]	28-52	40.5	1-7	4.2	0.8	0.03-0.31	0.17	0-0.12	0.06	—	0.9
Oat	40-45	42	2-7	3	0.6	—	0.21	—	0.08	0-0.9	—
Barley	38-42	40	3-5	4	0.8	—	0.34	—	0.09	0-0.9	—
Wheat	40-45	42	1-7	3	0.6	—	0.15	—	0.06	0-0.9	—
Rye	40-45	42	2-8	3	0.6	—	0.28	—	0.10	0-0.9	—
Silage (air dry):[d]											
Alfalfa[c]	—	46	6-23	14.3	10.0	—	1.16	—	0.23	0-56	14.1
Clover[c]	37-57	47	7-18	12.4	8.5	0.26-1.74	1.00	0.08-0.28	0.18	0-48	22.0
Alfalfa-grass[c]	42-58	50	7-19	13.3	7.3	0.28-2.32	1.30	0.09-0.41	0.25	10-56	33.4
Clover-grass[c]	41-55	48	8-17	12.4	6.8	0.27-1.39	0.83	0.07-0.31	0.19	28-89	59.0
Cereal[c]	42-58	50	5-14	9.4	5.2	0.12-0.48	0.30	0.08-0.36	0.22	0-49	15.0
Grass	—	45	7-12	10	5.5	—	0.40	—	0.20	11-44	—
Corn	—	54	4-16	8	4.0	—	0.33	—	0.23	0.4-62	—
Oat hulls:	30-35	32	2-10	4	0.08	—	0.10	—	0.11	—	—

[a] 1 mg beta-carotene = 400 I.U. Vitamin A.

[c] Values from Saskatchewan Feed Testing Lab. All other values were taken from NAS-NRC feed composition tables.

[d] Silage normally contains about 30% dry matter.

TABLE 3 (Continued) — COMPOSITION OF CONCENTRATES
(values based on 90% dry matter content)

Feedstuff	TDN Range (%)	TDN Average (%)	Crude Protein Range (%)	Crude Protein Average (%)	Digestible Protein (%)	Calcium Range (%)	Calcium Average (%)	Phosphorus Range (%)	Phosphorus Average (%)
Grains:									
Barley[a]	71-79	75	9-15	11.8	9.4	0.02-0.10	0.06	0.24-0.44	0.34
Oats[a]	64-76	70	8-15	11.1	8.9	0.04-0.12	0.08	0.22-0.38	0.30
Wheat[a]	77-87	82	12-19	15.4	12.3	0.01-0.09	0.05	0.25-0.49	0.37
Mixed[a]	65-81	73	8-16	12.0	9.6	0.02-0.14	0.08	0.13-0.53	0.33
By-products:									
Wheat middlings	71-73	72	17-22	18	14.4		0.10		0.90
Wheat red dog	68-74	73	16-24	18	14.4		0.08		0.52
Wheat bran	57-63	58	16-22	17	13.6		0.10		1.20
Oat groats	88-92	90	15-23	16	14.4		0.10		0.45
Beet pulp (Molasses)	68-72	70	6-12	9	5.8		0.60		0.05
Molasses (beet)	—	60	5-13	7	3.5		0.10		0.02
Molasses (cane)	—	70	—	3	1.0		0.50		0.05
Plant protein supplements:									
Soybean meal	72-83	75	40-51	44	37.4		0.20		0.60
Rapeseed meal	—	73	34-42	40	32.3		0.50		0.80
Linseed meal	69-78	71	31-42	35	29.8		0.35		0.75
Alfalfa meal (dehy.)	46-58	55[b]	19-27	22	15.4		1.49		0.32
Alfalfa meal (sundried)	46-58	55[b]	8-26	18	12.6		1.38		0.29
Brewers' dried yeast	65-75	70	33-54	44	37.4		0.10		1.40
Brewers' dried grains	60-68	66[c]	19-30	26	18.2		0.20		0.45
Animal protein supplements:									
Dried skim milk	-	85	29-37	33	29.7		1.25		1.00
Dried buttermilk	—	75	28-38	32	28.8		1.30		1.90
Meat scrap	—	72	51-67	58	49.3		8.50		4.18
Meat and bone scrap	50-67	65	40-55	50	40.0		10.00		5.00
Tankage	65-75	70	43-70	53	45.1		6.00		3.00
Fishmeal	65-80	72	60-75	71	63.9		3.00		3.00

[a] Values from Saskatchewan Feed Testing Lab. All other values were taken from NAS-NRC feed composition tables.
[b] Value for swine approximately 30% TDN.
[c] Value for swine approximately 42% TDN.

TABLE 3 (Continued) — COMPOSITION OF CONCENTRATES
(values based on 90% dry matter content) (continued)

Feedstuff	Riboflavin Range mg/kg	Riboflavin Average mg/kg	Nicotinic acid Range mg/kg	Nicotinic acid Average mg/kg	Pantothenic acid Range mg/kg	Pantothenic acid Average mg/kg	Vitamin B_{12} Range µg/kg	Vitamin B_{12} Average µg/kg	Thiamine Range mg/kg	Thiamine Average mg/kg	Pyridoxine Range mg/kg	Pyridoxine Average mg/kg
Grains:[a]												
Barley	1.2-2.1	1.6	62-109	85.2	4.5-12.3	8.4	—	0.0	3.6-5.4	4.5	5.0-8.6	6.8
Oats	1.1-1.9	1.5	9-18	13.6	3.1-10.9	7.0	—	0.0	5.4-7.6	6.5	1.7-3.6	2.6
Wheat	1.1-1.8	1.4	45-73	59.0	4.2-15.8	10.0	—	0.0	3.6-5.0	4.3	4.1-6.3	5.2
By-products:												
Wheat middlings	-	1.8	—	96.8	—	17.6	—	0.0				
Wheat red dog	—	1.5	—	52.6	—	13.6	—	0.0				
Wheat bran	—	2.2	—	143.0	—	2.6	—	0.0				
Oat groats	—	1.1	—	8.8	—	8.8	—	0.0				
Beet pulp (Molasses)	—	0.7	- -	13.2	—	1.1	—	0.0				
Molasses (beet)	—	2.2	—	37.4	—	4.4	—	0.0				
Molasses (cane)	—	2.2	—	44.0	—	37.4	-	0.0				
Plant protein supplements:												
Soybean meal	-	3.1	—	26.4	- -	13.23	-	0.0				
Rapeseed meal	—	3.3	-	154.0		8.6	—	0.0				
Linseed meal	—	2.9		44.0		14.1		0.0				
Alfalfa meal (dehy.)		15.4		30.8		37.41		30.8				
Alfalfa meal (sundried)		11.0		38.3		30.13		- -				
Brewers' dried yeast	—	33.0	—	446.6	-	110.03	—	0.9				
Brewers' dried grains	—	0.7	—	39.6	—	8.6	—	0				
Animal protein supplements:												
Dried skim milk	—	19.8	—	11.0	—	33.0	—	55.0				
Dried buttermilk	—	26.4	—	16.5	—	41.8	—	19.8				
Meat scrap	—	5.3	—	56.8	—	4.8	—	55.0				
Meat and bone scrap	—	5.5	—	46.2	—	4.0	—	50.6				
Tankage	—	2.2	—	39.6	—	2.2	—	44.0				
Fishmeal	—	8.8	—	88.0	—	11.0	—	297.0				

[a] Nik-Khah, A. et al. 1972. Can. J. Anim. Sci. 52:407-417. All other values were taken from NAS-NRC feed composition.

energy in a feed. For example, oats contain an average of 65 per cent TDN or 10 pounds of oats supplies 6.5 pounds of TDN (useful energy). A term similar to TDN is digestible energy (DE) which is a measure of useful energy in heat units or kilocalories (amount of heat required to raise 1 kg of water 1°C). One pound of TDN is equal to 2000 Kcal DE. (One kilogram of TDN equals 4400 Kcal DE.)

Tables listing the average nutrient composition of feeds are useful (Table 3). However, because of the extreme variation in the nutrient content of grains and hay, "book" values are only guidelines and are not very satisfactory for balancing high performance rations. For example, grains can vary from about eight to 14 per cent crude protein and hays from two to 24 per cent crude protein.

In Alberta, feed samples may be sent to the Provincial Feed Testing Laboratory, O.S. Longman Building, 6909 - 116 St., Edmonton, Alberta T6H 4P2. A detailed feed analysis includes moisture, energy, protein, calcium, and phosphorus measurements along with feeding recommendations if requested.

Grains

Oats, barley and wheat can all be used in horse rations. Whole oats are commonly used because they are palatable and easy to feed. Oats tend to be somewhat low in energy for high performing horses so additions of some barley or wheat may be desirable. Barley is an adequate grain for horses although horses should be given plenty of time to adjust to a barley ration. Barley is higher in energy than oats and may cause digestive trouble if fed irregularly. Barley should be coarsely rolled. Wheat can make up about one-half of a grain mixture for horses but proper feeding practices are essential. Wheat should be coarsely rolled. Avoid fine dusty material in grain rations for horses as it can lead to respiratory disorders.

Roughages

Alfalfa Hay

Alfalfa hay is possibly the highest quality roughage available. It is generally high in protein, vitamins and minerals. Alfalfa can be somewhat laxative and many horsemen dislike using alfalfa hay for working horses because it may make them sweat more readily. Alfalfa is more likely to be moldy and dusty than most other types of hay. A mixture of a grass hay and alfalfa is often used for raising foals and feeding broodmares.

Timothy

Although many horsemen prefer to feed timothy because it is generally dust-free and easy to feed, its nutrient content is low. Except for training, timothy hay is not a very practical horse feed.

Straw

Straw and chaff are too low in energy and protein to be considered as feeds for horses.

Silage

Silage can be fed to horses but the moisture content of silage may limit the dry matter consumption of the horse (e.g. a horse needs to consume three pounds of silage at 70 per cent moisture to obtain the same dry matter as one pound of hay). Silage can safely make up 50 per cent of the roughage requirements of brood mare and wintering rations. Other factors such as difficulty in storing and transporting silage and lack of palatability tends to limit the use of silage for horses.

Pasture

The quality of pasture can vary depending on climate, soil, species, etc. Poor or mature pasture does not supply enough energy for horses and supplemental feeding will be required for lactating or working horses. Young pasture may be too high in moisture for horses to obtain an adequate dry matter intake. In Alberta few pastures are ready for grazing prior to mid-May and after the end of July most pastures have reached maturity and lose their quality. One of the major differences between raising foals in Alberta as opposed to the southern United States is that we do not have high quality pastures for more than three or four months.

Protein Feeds

Soybean meal and linseed meal are commonly used as protein supplements for horses. Both are high in quality and well liked by horses. Prior to the use of the solvent method of extracting oil, linseed meal was preferred by horsemen because the residual oil acted as a hair coat conditioner. Too little oil is left in solvent extracted linseed meal to make it useful as a conditioner. Soybean meal is better quality and is usually a more economical source of protein. Protein supplements are generally not well liked by horses until they become accustomed to them.

Mineral Mixes

Good commercial mineral mixtures that contain calcium, phosphorus, salt and some trace minerals are available. One can purchase ground limestone as a source of calcium or bonemeal as a source of calcium and phosphorus if home mixing is desired. Foals and yearlings will not consume adequate amounts of mineral on a free choice basis so minerals have to be added to their grain. Proper mineral levels and rations are extremely important in horse growing rations. The most useful commercial mineral mixture is a 2:1 (20 per cent calcium, 10 per cent phosphorus) mix with added salt and trace minerals.

	Ca (%)	P (%)
Bonemeal (steamed)	24.0	13.0
Dicalcium phosphate	26.0	18.5
Defluorinated rock phosphate	34.0	14.5
Curacao Island phosphate	35.0	15.0
Soft phosphate (colloidal clay)	18.0	9.0
Ground limestone	38.0	0

Vitamin Mixes

Buy vitamins on the basis of international units (I.U.). Good commercial products are available but remember that:

1. Vitamin A is the main vitamin required and it costs about 10 cents per million I.U.'s. Vitamin D is usually added with Vitamin A at little extra cost.
2. The B-vitamins are of questionable need, especially for light work and their cost may not justify their use except for training race horses or for foals.

Other Feeds

Wheat Bran

Wheat bran is the coarse outer coating of wheat kernels removed during the milling process. Bran is useful in horse rations because it is palatable, mildly laxative and adds bulk to the ration. Bran may be included at five to 10 per cent of rations for pregnant or lactating mares or for stabled horses that are not worked regularly.

Beet Pulp

Beet pulp adds bulk to a ration and is quite palatable. It is not very high in nutritive value but it can be added at five to 15 per cent of the ration in place of roughage.

Molasses

Molasses aids in improving the palatability of rations, decreases dustiness and is mildly laxative when added at two to five per cent of the ration. Molasses is low in protein but is quite a good source of energy. Molasses gets very stiff when cold so may require heating prior to mixing.

Pelleted Dehydrated (Dehy) Alfalfa Meal

The addition of five to 10 per cent of pelleted alfalfa meal in horse rations may be beneficial. Alfalfa meal supplies vitamins, minerals, protein and possibly other factors of nutritional benefit. Dehy is a convenient roughage to handle, especially when transporting horses.

Brewer's Dried Yeast

Brewer's yeast is high in protein and is an excellent source of B-vitamins when added to the ration at approximately one per cent.

Stabilized Tallow

Tallow may be added to horse rations at one to two per cent for dust control, and as a conditioner. Tallow is high in energy (200 per cent TDN) and is used quite well by horses even though they do not have a gall bladder. An oil or fat such as tallow aids in giving a shine to horses' hair coat. Tallow may limit feed intake until horses become accustomed to it. Large amounts of fat may be too laxative.

Conditioners

Conditioners generally have little or no nutritive value and thus are not generally recommended. If the feeding program does not keep horses in top condition, it is due to nutritional inadequacies and it is doubtful that conditioners will help much. In general, beware of "shot-gun" preparations and "cure-alls".

Complete Feeds

Feed manufacturers are able to purchase feed in volume and have experienced personnel formulating rations. Pelleted feeds reduce bulk, are easy to handle, prevent sorting of feed and eliminate dust. The disadvantage of pelleted rations is that not enough bulk is provided to satisfy appetite so some horses will chew on fences and other things if some long roughage is not fed along with pellets.

Commercial preparations are particularly good for raising foals and for the owner that does not understand horse nutrition.

RATION FORMULATION

To formulate a ration, we must know the nutrient requirements of the horses to be fed, the nutrient content of the available feeds and the comparative costs of available feeds.

Steps

1) Look up the nutrient requirements of the horses that are being fed and list them as in the example.

2) Select and feed roughage at the desired daily level. Use the following guide or levels based upon practical experience. Horses should not be allowed to eat all the roughage they will eat during training or showing as they develop too large an abdomen and lack agility and speed.

Production	Quality	lbs hay/ 100 lbs body weight
Maintenance & growth	— Excellent hay	2 - 2.2
	— Normal	1.5 - 2.0
	— Poor	1 - 1.5
Pregnancy	— Excellent hay	2
	— Normal	1.5
Lactation	— Excellent hay	2.0
	— Normal	1.5
Light work	— Normal	1.2 - 1.5
Medium work	— Normal	1 - 1.2
Heavy work	— Normal	0.5 - 1

3) Add enough of a desired grain mix per day to bring TDN up to requirement. Do not worry about exceeding the daily feed requirement. Horses can eat more than Table 1 indicates but caution is advised so that they do not get too gutty.

4) Check to determine if adequate protein, calcium, phosphorus, vitamin A, etc. is being supplied and use appropriate supplements.

Example

Formulate a ration for an 1100 pound Quarter horse that is being trained for two hours daily (light work). Assume brome hay, oats, soybean meal, dicalcium phosphate, salt and injectable vitamins A and D are the feedstuffs available.

1) Requirements (per day basis)

Energy (TDN)	11 pounds (5.0 kg)
Crude Protein	1.77 pounds (0.8 kg)
Calcium	20 g
Phosphorus	15 g
Vitamin A	12,500 I.U.

2) Hay Feeding

Assume feeding rate of 1.2 pounds of brome hay per 100 pounds body weight.

1.2 lbs/100 lb horse x 1100 lb = *13.2 lb brome hay*

This supplies lbs of hay x TDN of hay = pounds TDN

This supplies 13.2 x 48/100 = 6.34 lb TDN

3) Grain Feeding

TDN requirement is 11.0 lb. Hay supplies 6.3 lb.

Horse is short (11.0 - 6.3) = 4.7 lb TDN

To supply 4.7 lb TDN; oats at 65% TDN; need ? lb of oat.

4.7 lb. TDN from oats; 4.7 ÷ 0.65 = 7.2 lb oats.

4) Check Protein, Minerals, Vitamins

	lb/day	Protein	Calcium	Phosphorus	Vit. A
Brome Hay	13.2	1.58 lb	24 g	12 g	?
Oats	7.2	0.94 lb	2 g	10 g	0
TOTAL	20.4	2.52	26 g	22	

As you can see this ration of good quality brome grass, hay and oats meets the Quarter horse's requirement for TDN and has some slight surpluses of protein, calcium, and phosphorus. Also, the ratio of calcium to phosphorus is 1.25:1 which is ideal. The slight excesses will not affect the horse and means these nutrients do not have to be supplemented. The diet has questionable amounts of vitamin A and no salt, so all the horse now needs is free-choice clean fresh water, free-choice salt and a vitamin A supplement.

PRACTICAL FEEDING UNDER VARIOUS CONDITIONS

Winter Management

Wintering horses requires some special consideration. Winter conditions increase the horse's energy requirement up to 50 per cent depending upon the wind, temperature, moisture, condition of the horse, type of shelter and type of feed. Most breeds of horses will grow a heavy coat of hair during the fall if they are housed outside. This hair coat is very efficient in helping to keep the horse warm provided there is protection from wind and moisture and an adequate diet. If a horse is exposed to wind, the insulating value of the hair coat is greatly reduced and the animal suffers from exposure during cold periods. Horses will always turn with their tails toward the wind and put their heads down to expose as little surface area to the wind as possible. Moisture in the form of either rain or snow greatly increases the stress of cold as it will penetrate the protective hair coat.

Horses tend to fatten externally (especially over the back and ribs) and this provides very good protection from winter conditions. A recent Alberta study indicated that fat beef cows with no shelter increased their energy requirement by approximately 29 per cent during cold weather while thin cows increased their needs by approximately 66 per cent during cold weather. Similar research results with horses is not available but it is obvious that thin horses require much more feed and are affected more during cold winter conditions. Since horses do not normally "bed down" as cows do, the use of straw for bedding offers little protection to the horse.

Minimum protection from wind and moisture during cold winter conditions can be provided by a large thick bluff of trees or preferably a three-sided pole shed. The pole shed should allow approximately 15 - 25 sq. feet (1.4 - 2.3 m^2) of space per horse. The shed should be open to the south to allow sun rays to enter the shed and to be protected from most winds. Openings in the rafters at the back of the shed will allow for proper air flow. A tight shed will lead to dead air spaces, drafts and snow drifts. The shed should be approximately 12 feet (3.7 m) high in front and 8 feet (2.4 m) high at the back to allow for manure build-up and adequate room for cleaning with a front-end loader. The saving in winter feed and the improved comfort of the horse should offset the construction costs.

One should avoid moving horses into a warm barn during cold periods as it is difficult for them to acclimatize to the cold when put back outside. Horses kept in a barn continually require some special consideration during the winter. These horses do not acclimatize to the winter by growing as heavy a hair coat and therefore will suffer from cold if placed outside for long periods during cold weather. These horses should be allowed outside for one to two hours per day for exercise but they should not be expected to lounge, eat and drink outside during the winter as it is too stressful.

Barns are difficult to ventilate so that when a number of horses are housed in one barn there is a tendency for the humidity to build up. This is unhealthy for the horses because they are more easily chilled and more prone to respiratory problems. High humidity is also damaging to the wood and metal in the barn. The major reason for ventilating a barn during the winter is to remove moisture produced by the horses.

Barns can also be too dry because of the low moisture content of cold air. If the barn is too dry, respiratory and dust problems may develop. The optimum relative humidity is approximately 60 per cent and the optimum temperature is approximately 10°C.

Because of less exercise and no cold stress, horses kept in barns during the winter require less feed than those kept outdoors. Since horses in barns receive little exposure to sunlight, vitamin D has to be supplemented on a regular basis. Barn-kept horses may require some bran or molasses in their diet to prevent constipation. Also, some barn managers use pelleted roughage to reduce coughing that sometimes results from dry, dusty feeds.

Pregnancy

A mare's gestation or pregnancy is approximately 340 days (11 months). Mares under 900 - 1,100 pounds bodyweight may foal a few days earlier and heavier mares may be a few days later.

During the first six to eight months of pregnancy, a mare requires no special attention as the fetus increases relatively little in weight during this period (approximately 30-40 pounds). The feeding program should allow the mare to maintain her weight and health. A pasture program is the most convenient method although example rations are shown in Table 4. The training or working program need not change during the first six months of pregnancy.

During the last three to five months, the pregnant mare should receive about a 20 per cent increase in nutrient intake (example grain rations, Table 4). Particular attention should be given to supplying supplemental vitamin A as it is one deficiency that can cause abortion. If the feed is low in quality, supplemental protein in the form of linseed meal or soybean meal may be necessary. Shortly before foaling, a feed that is mildly laxative (bran, molasses) may be necessary to prevent constipation especially if the mare is kept indoors. Mares should not be allowed to become ex

cessively fat during pregnancy. The mare should be allowed to foal in a clean quiet area such as a small pasture or a disinfected roomy box stall that is bedded with clean straw.

Milk Production

During the first day of lactation, a mare produces a very high quality milk known as colostrum. Besides being high in energy, protein, vitamins and minerals, colostrum contains antibodies against many of the bacteria that may affect foals. The foal has the ability to utilize these antibiotics for only a short period of time (less than 24 hours) so it is important to have a foal suck within two or three hours of birth and frequently thereafter. Colostrum increases the resistance of the foal's digestive system to bacterial infection and the foal generally has little chance of surviving without first receiving colostrum.

Mare's milk is more dilute in terms of energy and protein than cow's milk but contains a higher sugar content making it sweeter. Mares reach maximum milk production approximately one month after foaling. Mares generally produce 30 to 60 pounds of milk daily depending upon type of diet, how often the foal sucks and the mare. This heavy output of milk greatly increases the mare's requirement for all nutrients. Therefore, lactating rations require ample high quality roughage. It takes an exceptionally good pasture to meet the heavy demands of lactation. Many mares lose considerable weight during early lactation due to improper feeding programs. Also, the improperly fed mare will not produce adequate levels of high quality milk for a foal. Most deficiencies in the mare's diet can be assumed to be present in the milk as well. Also, mares that are losing weight during lactation are difficult to rebreed. A mare will normally lactate for six to eight months if on good feed. After four or five months, the foal receives most of its nutrients from non-milk sources so creep-feeding and early weaning are often warranted.

Rebreeding Lactating Mares

If a mare is pregnant for 340 days, she has only 25 days to become rebred and have a foal the same time the next year. If the mare is allowed a longer recovery period, she will have to miss foaling one year to "catch-up". The period from foaling to rebreeding is extremely critical as the mare has to repair her reproductive tract after foaling, produce milk for the foal and become rebred — a big order in a short period.

Mares conceive more readily if they are gaining in condition while lactating. Getting enough energy into the mare is the major feeding problem that occurs during rebreeding. Mares will generally show heat about nine days after foaling (foal heat). Since most mares have not properly repaired their reproductive system for rebreeding, conception rates are low (21 - 43 per cent in one study) and abortions occur more often with breeding on the foal heat.

Rearing Foals

The first year of life for a horse is the most critical one from a feeding and management aspect. Throughout Western Canada, mature horses tend to be overfed while foals more often than not tend to be underfed. Foals should reach 45 per cent of their mature weight by the time they are six months of age and 65 per cent of their mature weight by one year of age. A horse that has the genetic potential to be 1,100 pounds (500 kg), should be approximately 500 pounds (230 kg) at weaning and over 700 pounds (320 kg) at one year of age. The foal would have to gain weight at a rate of two pounds/day (0.9 kg/ day) up to six months and 1.5 pounds/day (0.7 kg/day) during its first winter.

Foals require a very high quality ration to grow according to their potential and as a result few make it. A growing ration for foals must be particularly high in protein (14 per cent), calcium (0.75 per cent) and phosphorous (0.50 per cent) so that force feeding of these components is required unless the natural feeds are very high in quality and are properly balanced.

Foals cannot obtain sufficient nutrients for proper growth while on pasture or when fed with more mature horses. Foals should either be creep-fed or weaned after the end of July as pastures in Western Canada are mature which greatly reduces milk production in mares and provide poor nutrition for foals. Rations used for creep feeding can be the same grain mixture used for wintering weanlings (Table 4). Besides being high in nutrients, the ration should contain feeds that are palatable to young horses such as oats, bran, molasses, soybean meal and bonemeal. Some feeds acceptable to mature horses may be unacceptable to foals. Foals should be started on new feeds gradually so as to adapt their digestive system to the change in diet. A properly balanced commercial horse ration is recommended for foals as they avoid the problem of improper mixing and sorting of supplements.

Foals should not be weaned until they have adapted to their post-weaning diet and until they are familiar with their new surroundings. Weaning should be carried out with as few stresses as possible. Foals can handle the stress of being away from their mother and her milk but if stresses such as new feed, new surroundings or transportation are imposed, the risk of disease is greatly increased.

Foals should be weaned in a strong wooden corral that is clean, roomy and free from injurious corners, troughs, and other objects as foals usually get very upset for two to three days post-weaning. The mares should be moved far enough away so they

cannot see or hear each other.

The foals can be self-fed, although care should be given to adapting foals to the self-feeder and to mixing a ration so ingredients cannot be sorted. One major advantage of self-feeding is that foals can eat several times per day and there is no competition for feed. Hay and grain can be fed separately but one ingredient should be limited.

Colts and fillies should be separated after eight or 10 months of age when sexual activity is apparent. Foals are playful and require considerable room to exercise so plenty of space should be available [300 - 500 sq. feet per head (28 - 47 m^2/head)]. One expects the foal to grow up to be athletic and proper development of muscles and coordination needs to start very early in life. Deep snowfall and poor footing in Western Canadian winters restricts horses' natural tendency to properly exercise themselves. Handling the foal is important and the younger initiated the better. Weaned foals should be halter-broke and some time should be spent grooming the foals and picking up their feet.

TABLE 4. SOME PRACTICAL GRAIN MIXTURES

	TYPE OF RATION				
Ingredients	Foals and yearlings %	Maintenance (wintering) %	Late Pregnancy %	Lactation %	Training %
Oats (rolled)	44.0	97.5	75.5	45.5	60.0
Barley (rolled)	40.0	—	—	30.0	30.0
Wheat bran	—	—	10.0	5.0	—
Soybean meal	5.0	—	5.0	5.0	—
Alfalfa meal pellets	5.0	—	5.0	10.0	5.0
Molasses	2.0	—	2.0	2.0	2.0
Bonemeal (or Calcium phosphate)	2.0	1.0	1.0	1.0	1.0
Ground Limestone	0.5	—	—	—	0.5
Iodized salt	1.0	1.0	1.0	1.0	1.0
Vitamin premix[1]	0.5	0.5	0.5	0.5	0.5
	100	100	100	100	100
Daily allowances (lb/100 lb horse)					
Grain mixture[3]	1.0-1.5	0-0.5	0.5-1.0	1.0-1.5	0.5-1.5
Hay	1.0-1.5	1.25-1.75	1.25-1.75	1.5-2.0	0.5-1.5

Note:

1. Vitamin premix should contain 800,000 I.U. vitamin A and 40,000 I.U. vitamin D per lb.

2. One grain mixture can be used for wintering, pregnancy, lactation and training as they are quite similar.

3. Use the lower level of grain feeding with the higher level of hay feeding and vice versa.

4. The weight of a horse can be estimated:

$$\text{Wt. (lbs.)} = \frac{\text{heart girth (in.)} \times \text{heart girth (in.)} \times \text{length (in.)}}{300} + 50$$

Heart girth is measured as the circumference of the horse taken right behind the front legs. Length is measured from the point of the shoulder to the tail head.

Yearlings and Two-Year Olds

Yearlings and two-year olds can be handled together. Horses grow till they are three to four years of age but at decreasing rates. For example, a 700 pound (320 kg) yearling that will reach a mature weight of about 1,100 pounds (500 kg) should gain about one pound/day (0.45 kg/day) during its second summer (12 - 18 months) and about 0.5 pound/day (0.2 kg/day) during its second winter (18 - 24 months). Weight gain after two years of age will vary considerably. As a guideline, average weights of 700, 880, 970 and 1,050 pounds at 12, 18, 24 and 36 months respectively are realistic.

Good pasture is the most economical and desirable method of growing yearlings and two-year olds. If supplemented with minerals, sufficient nutrients will be supplied and the horses will obtain adequate exercise. As the pasture matures in the fall, quality is reduced and supplemental protein and vitamins become necessary. During the winter, yearlings and two-year olds can be maintained on high roughage rations. Since yearlings and two-year olds do not compete well with mature horses they should be fed separately.

Time of castration depends upon such things as handling facilities, selection programs, training programs, as well as individual preferences. Young horses suffer less stress when castrated than older horses (two-year olds) and geldings are easier to handle, train, pasture and winter. However, stallions grow faster, develop more muscle and are stronger than geldings. The horseman has to balance the advantages of leaving colts intact as long as possible so as to promote development of size, speed and muscle against the problems encountered in handling young stallions. Most race horses are left intact until they have matured while most grade horses are best castrated at either 12 or 24 months. Castrations should be carried out by an experienced veterinarian as horses are more difficult to castrate than other classes of livestock. Castration should be done either in the spring prior to the fly season or in the fall after freeze-up.

The selection and maintenance of stallions require considerable experience, special facilities and superior stock. For every colt born only about one in 200 needs to be retained for breeding stock. With broader use of artificial insemination, this ratio may become as broad as one in every 500 horses born. The time, feed, care and money that goes into breeding, raising, training and maintaining a horse is too great to sacrifice quality of stallions for quantity. For

example, to have a trained rope horse, it takes approximately five years, 10 tons of feed, 50 acres of pasture, 1,000 hours of training, or $1,500. This is too large an investment to throw away because of a $50 difference in stud fees.

Training

A good trainer has to put into use practical techniques of nutrition, psychology, medicine and fitness.

Feeding during training is as much an art as a science as one has not only to meet the nutrient requirements of the horse but the nutrients have to be supplied in a manner that complements the fitness part of the program.

Trainers of racing horses tend to use minimum amounts of roughage to reduce the size of the horse's abdomen and the bulk carried in the digestive system. This reduced bulk means less weight carried, less heat produced while digesting feed and greater endurance. Horses do require a minimum of about 0.5 pounds of fibrous feed per 100 pounds body weight. This is for proper passage of food through the digestive system and to satisfy appetite.

Roughage should be limited to about one pound/100 pounds body weight for the training and working of all classes of horses. The lack of roughage for race horses reduces bacterial fermentation in the cecum and colon so supplemental feeding of water soluble vitamins becomes necessary. Also, the stress of heavy training reduces the efficiency of digestion of some nutrients (energy) and increases the requirement of others (energy, vitamin A).

Adequate levels of a palatable source of protein should be fed but exercise does not substantially increase protein requirements.

Most trainers prefer a hard, clean roughage source such as timothy or crested wheat grass hay as opposed to alfalfa. Although timothy hay is low in nutrients, it is palatable to horses, is generally free of dust and mold and adequately serves as a source of fiber. Alfalfa hay is more readily digested by microorganisms in the cecum and colon. This faster rate of fermentation keeps the horse warmer and is probably one reason horses fed on alfalfa perspire more. Also, alfalfa is often too high in protein for race horses and is more prone to be dusty or moldy. Since a horse's performance depends to a large extent on its cardiovascular efficiency which includes efficient respiration, dusts and molds are not tolerated in horse feeds.

Since the horse has evolved as an animal that eats small amounts several times a day, it has a small stomach. During heavy training a horse should be fed a minimum of three small meals daily with most of the daily roughage allowance given at night. Considerable individual variation exists between horses so each horse is fed differently. Judgment is used to avoid getting horses in training too fat or too thin. There are no secret feed ingredients that make horses run faster; simply knowledge of the needs of the horse for nutrients, experience with feeds to know which roughage and how much to use, what vitamins and other supplements to use, as well as what feeds are well-liked and are digested without problems. Feeds prone to be too laxative or produce excessive heat or gas are avoided. In general, diets need not be complex to be good as the horse's needs are relatively simple (Table 4). There are some excellent commercial feeds available for horses in heavy training.

The psychological aspect of training should be considered. Horses have a relatively small brain and are not gifted with the amount of intelligence many horse lovers would like to credit them with. Most of the horse's actions are based upon instincts and memory; both of which are well developed in horses. Considerable breed differences exist however. For example, Quarter horses are easily trained as stock horses, Standardbreds have a natural tendency to trot or pace and Thoroughbreds find running very natural. Choose the breed that has a natural instinct towards the training program you choose.

One of the strongest instincts in horses is that of responding to commands of a leader. Most horses want to be "led" or shown the way. They find security in following the directions of a trainer and this is probably one reason horses are so easily taught to do many varied exercises. Good trainers take advantage of this instinct by being consistent and thorough in the training program so the horse knows what is required of him at all times.

A horse also responds to discipline and reward if presented in a consistent uniform manner that the horse can relate to. Discipline may vary depending upon how nervous or sensitive the individual horse may be. Strong voice tones followed by repeating the desired exercise may be sufficient discipline for most horses. The horse should also be made to carry out exercises requested as the horse will remember the incidence. One sign of a good trainer is not to attempt exercises that the horse is not ready for. The training program should progress gradually giving the horse plenty of time to feel comfortable with each new procedure. A horse should not be forced to concentrate for more than about 15 minutes on one exercise as they soon lose interest. During a training session the horse should be required to review past exercises prior to spending about 10 minutes with a new program. As important as discipline is reward. The horse can be rewarded with a gentle voice, a pat on the neck or maybe a rest. Normally a horse should not be rewarded with food.

The fitness part of the training program varies in importance depending upon what the horse is being trained to do. A horse will normally exercise itself well

enough for light work if given the opportunity.

For heavy work the horse needs to be conditioned, warmed-up and cooled down in a manner consistent with an athlete. The horse should be warmed-up with a light regular routine familiar to the horse. The conditioning program should be one in which the horse is required to build up strength, endurance and cardiovascular fitness over several weeks. Care should be taken so as not to overwork the horse to the extent that injury may result. After a workout the horse should be cooled down by slow walking. The horse should not be allowed water or grain for at least an hour after a heavy workout. Water should be given in small amounts to avoid having the horse gorge itself. After a workout, the horse should be thoroughly groomed to remove dried perspiration and dirt. Light training can begin when a horse is three years old but heavy training should not begin until the horse is four or five years old as their skeletons are not strong enough to withstand a lot of stress at a young age.